MAY 1774.

DESCRIPTION

Of a new Univerſal Equatoreal, made by Ramſden, with the Method of adjuſting it for Obſervation.

THE Principal Parts of it are:

Iſt. The Azimuth or Horizontal Circle (A) (repreſenting the Horizon of the Place) which moves on a long Axis (B) called the Vertical Axis.

IId. The Equatoreal or Hour Circle (C) repreſenting the Equator placed at right Angles *to*, and moving *upon* the *Polar Axis* (D) which repreſents the Axis of the Earth.

IIId. The Semi-Circle of Declination (E) (on which the Teleſcope is placed) moves on what is called the Axis of Declination, or, *the Axis of Motion of the Line of Collimation*. (F)

IVth. Meaſures of the ſeveral Circles and Diviſions on them.	Radius In. dec.	Limb divided to	Nonius of 30 gives ſeconds.	Divided on limb to parts of In.	Divided by nonius to parts of In.
Azimuth or Horizontal Circle, - - - -	5 - 1	15′	- - 30″ -	- - 45th. -	- - 1350th.
Equatoreal or Hour Circle, - - - - -	5 - 1	15′ 1′ time	- - 30″ - - - 2″ -	- - 45th. -	- - 1350th.
Vertical Semi-Circle for Declination or Latitude, - - -	5 - 5	15′	- 30″ -	- - 42d. -	- - 126oth.

Vth. The Teleſcope is an Achromatick Refractor with a triple Object Glaſs, the Focal Diſtance whereof is 17 In. Dec. Inches and its Aperture: 2: 45: and there being ſix different Eye-Tubes, its Magnifying powers run from 44 to 168. By a new Contrivance in this Equatoreal, the Te-

leſcope may be brought parallel to the Polar Axis, ſo as to point on the Pole-Star in whatever part of its apparent diurnal revolution it be, and with this Teleſcope it has been ſeen near 12 o'clock at noon, and the ſun ſhining very bright.

VIth. The Refraction Apparatus (for correcting the error in altitude occaſioned by Refraction) goes on upon the Eye-End of the Teleſcope, and conſiſts of the following parts.

1ſt. A Slide (G) which moves in a Groove or Dove-tail, and carries the ſeveral Eye-Tubes of the Teleſcope: this ſlide has an Index on it, correſponding to five ſmall diviſions engraved on the Dove-tail.

2d. A very ſmall Circle, called the *Refraction Circle* (H) moveable by a Finger-Screw at the extremity of the Eye-End of the Teleſcope; this Circle is divided to half minutes, but only numbered to minutes; one entire revolution of this Circle is equal to 3′. 18″: The moving of this *Refraction Circle* raiſes the center of the Croſs Hairs on a *Circle of Altitude*.

3d. A Quadrant (I) of 1 ½ Inch. Radius with diviſions on each ſide, one expreſſing the degree of altitude of the object viewed, the other expreſſing the minutes and ſeconds of error occaſioned by refraction, correſponding to that degree of altitude—to this Quadrant there is joined a ſmall round Level, (K) which is adjuſted partly by the Pinion, (which turns the whole of this apparatus) and partly by the Index of the Quadrant; whatever minute and ſecond of error the Index points to on the Limb of the Quadrant, ſet the *Refraction Circle* to the ſame minute, &c. If the minute, &c. given by the Quadrant, exceed the 3′. 18″. contained in one entire Revolution of the *Refraction Circle*, ſet the *Refraction Circle* to the exceſs, above one or more of its *entire* Revolutions; then the center of the Croſs Hairs will appear to be raiſed on a

Circle of Altitude to the additional height which the Error of Refraction will occaſion at that Altitude.

VII^th. This Inſtrument ſtands on three feet, (L) diſtant

In.	Dec.
14.	4.

from each other

VIII^th. When all the parts are horizontal, it is about 29 inches high.

	Averd. wt.
IX. This Equatoreal weighs — —	lb. 56
Small Box with the Eye-Tubes and the reſt of its Apparatus, ——	3
Mahogony Caſe of the Equatoreal, —	58
	lb. 117

Before you proceed to adjuſt this Inſtrument, conſider well the ſeveral parts of it, and you will ſee, that the principal adjuſtment thereof (to which every other adjuſtment muſt tend) is to make the *Line of Collimation* (that is, the Line of Viſion in the Teleſcope) deſcribe a portion of an *Hour Circle* in the Heavens—in order to *that*, it is plain, that ſeveral previous adjuſtments muſt be made; ſuch as, that the Azimuth Circle muſt be truly level—that the *Line of Collimation* (or ſome ſubſtitute thereof, entirely correſpondent to it) muſt be at right Angles to the Axis of *its own proper motion*, and that this laſt Axis muſt be at right Angles to the Polar Axis, or Axis of the Earth; the Polar Axis, by the conſtruction of the Equatoreal (without any adjuſtment) is at right Angles to the Equatoreal Circle.—— There is a ſmall Braſs Rod (M) placed immediately under the Teleſcope, which is meant to be parallel *to*, and the ſubſtitute *of*, the Line of Collimation, and (as above mention'd) is entirely correſpondent to it, and to be conſi-

der'd as one and the ſame thing with it, in going thro' the 2d. 3d. 4th. Adjuſtments—On this braſs rod there is occaſionally placed a hanging Level, (N) the many advantages of which in various operations, the following Adjuſtments will clearly ſhow.

1ſt ADJUSTMENT.
Level the Azimuth Circle.

Turn it, till one of the Levels is parallel to a ſuppoſed line joyning two of the feet ſcrews, then adjuſt that Level with thoſe two feet ſcrews; turn the Circle half round, *i. e.* 180.°, and if the bubble be not then right, correct half the error by the ſcrew belonging to the Level, * and the other half error by the aforeſaid two feet ſcrews; repeat this till the bubble comes right——then turn the Circle 90.° *from* (that is, at right angles *to*) the two former poſitions, and ſet the bubble right (if it be wrong) by the foot ſcrew at the end of the Level; that done, adjuſt the other Level by its own ſcrew, and the Azimuth Circle will then be truly Level.

2d ADJUSTMENT.
Make the two Hooks of the Hanging Level equal in length; ſo that the Level may be truly parallel to the Braſs Rod, on which it is ſuſpended.

Hang on the Level; make the Polar Axis perpendicular to the Horizon, or nearly ſo, then adjuſt the Level by the Pinion of the declination Semi-Circle; reverſe the Level, and if it be wrong, correct half the error by a ſmall ſteel ſcrew that lies under one end of the Level, and the other half error by the Pinion of the declination Semi-Circle; repeat this, till the bubble be right in both poſitions.

3d ADJUSTMENT.
Make the Braſs Rod on which the Level hangs, at right Angles to the Axis of Motion of the Teleſcope, or Line of Collimation.

Make the Polar Axis Horizontal, or nearly ſo; ſet the declination Semi-Circle to 0°. turn the Hour-Circle till the bubble comes right; then turn the declination-Circle to 90.°; adjuſt the bubble by raiſing or depreſſing the Polar Axis (firſt by hand till it be nearly right, afterwards to

* Obſerve when the point of any Screw is *tap'd* into the ſurface it preſſes upon, then by *ſcrewing* you *depreſs* and by *unſcrewing* you *elevate* that part, but when the point of a Screw is *not tap'd* into the ſaid ſurface (as the Feet Screws of the Equatoreal) then *ſcrewing elevates*, and *unſcrewing depreſſes*.

make it entirely right, tighten with the Ivory Key the ſocket which runs on the Arch with the Polar Axis, and then apply the ſame Ivory Key to the adjuſting ſcrew at the end of the ſaid Arch till the bubble comes quite right) then turn the Declination-Circle to the oppoſite 90.°, if the Level be not then right, correct half the error by the aforeſaid adjuſting ſcrew at the end of the Arch, and the other half error by the *two ſcrews* which raiſe or depreſs the end of the *braſs rod*——N. B. theſe ſcrews preſs againſt each other, ſo you muſt be unſcrewing the one, while you are ſcrewing the other.

4th. ADJUSTMENT. Make the Axis of motion of the Teleſcope at right Angles to the Polar Axis, or Axis of the earth.

The Polar Axis remaining, nearly Horizontal, as before and the declination Semi-Circle at 0°. adjuſt the bubble, by the Hour-Circle, then turn the declination Semi-Circle to 90°. and adjuſt the bubble by raiſing or depreſſing the Polar Axis; then turn the Hour-Circle 12 Hours, and if the bubble be wrong, correct half the error by the Polar Axis, and the other half error by the two pair of capſton ſcrews, at the feet of the two ſupports, *or one ſide* of the *Axis of Motion* of the Teleſcope.

REMARK.

By the three laſt adjuſtments you have brought the Level to be truly parallel to the braſs rod and the ſaid *braſs rod* (or, line of collimation, which for the preſent is to be conſider'd as the ſame thing) to be at right angles to the Axis of its own motion, and this laſt Axis to be at right angles to the Polar Axis, or Axis of the earth.

5th. ADJUSTMENT. Make the center of Croſs Hairs remain on the ſame object, while you turn the Eye-Tube quite round by the Pinion of the Refraction Apparatus.

Set the Index on the *Slide* to the firſt diviſion on the dove-tail; and ſet the diviſion mark'd 18° on the *Refraction Circle* to its Index; then look thro' the Teleſcope and with the Pinion turn the Eye-Tube quite round, and if the center of the hairs does not remain on the ſame ſpot during that revolution, it muſt be corrected by the four ſmall ſcrews, two and two at a time, (which you will find upon unſcrewing the neareſt end of the Eye-Tube that contains the firſt Eye-Glaſs) repeat this correction till the

center of the hairs remains on the ſpot you are looking at during an entire revolution.

6th. ADJUSTMENT. Make the Line of Collimation parallel to the Braſs Rod on which the Level hangs.

Set the Polar Axis Horizontal, and the declination Circle to 90.°, adjuſt the Level by the Polar Axis; look thro' the Teleſcope on ſome diſtant Horizontal object, covered by the center of the Croſs Hairs; then invert the Teleſcope, (this is done by turning the Hour-Circle half round or 12 hours) and if the center of the Croſs Hairs does not cover the ſame object, as before, correct half the error by the uppermoſt and lowermoſt of the four ſmall ſcrews at the Eye-End of the large Tube of the Teleſcope; this correction will give you a *ſecond object* now cover'd by the center of the Hairs, which you will adopt inſtead of the *firſt object*, then invert the Teleſcope as you did before, and if the ſecond object be not covered by the center of the Hairs, correct half the error by the ſame two ſcrews you uſed before; this correction will give you a *third object*, now cover'd by the center of the Hairs, which you will adopt inſtead of the ſecond object, repeat this operation till no error remains; then ſet the Hour-Circle exactly to 12 hours, (the Declination-Circle remaining at 90.° as before) and if the center of the Croſs Hairs does not cover the *laſt object* fixed on, ſet it to that object by the two remaining ſmall ſcrews at the Eye-End of the large Tube, and then the line of collimation will be parallel to the braſs rod.

7th. ADJUSTMENT. Rectify the Nonius of the Declination and of the Equatoreal Circles.

Elevate the Equatoreal Circle to the Co-Latitude of the place, * and ſet it to ſix hours; adjuſt the Level by the Pinion of the Declination Circle; then turn the Equatoreal Circle *exactly* 12 *hours* from the *laſt poſition*; and if the Level be not right, correct one half of the error by the

* Thus—lower the Teleſcope as many Degrees, Minutes and Seconds below 0°. (or Æ) on the Declination Semi-Circle, as the complement of your Latitude is; then elevate the Polar Axis till the Bubble be Horizontal, and the Equatoreal-Circle will be elevated to the Co-Latitude of the Place, as required.

Equatoreal Circle; and the other half by the Declination Circle; then turn the Equatoreal Circle back again, exactly 12 hours from the laſt poſition, and if the Level be ſtill wrong, repeat the correction as before till it be right when turned to either poſition; that being done, ſet the nonius of the Equatoreal Circle exactly to ſix hours, and the nonius of the Declination Circle, exactly to 0°.

The principal Uſes of this Equatoreal are:

1ſt. To find your Meridian by *one obſervation only*.—

To do this, elevate the Equatoreal (or hour) Circle to the Co-Latitude of the place, and ſet the declination Semi-Circle to the ſuns declination for the day, and hour of the day required; then move the Azimuth and Hour-Circles, both at the ſame time, either in the ſame direction, or the contrary, till you bring the center of the Croſs Hairs in the Teleſcope exactly to cover the center of the Sun: that being done, the Index of the Hour-Circle will give you the apparent, or ſolar time at the inſtant of obſervation—thus you get the time, tho' the Sun be at a diſtance from the Meridian—then turn the Hour-Circle till the Index points preciſely at 12 o'clock, and lower the Teleſcope to the Horizon in order to obſerve ſome point *there*, in the center of your Glaſs, and that point is your Meridian mark found by *one obſervation only*—the beſt time of the day for this operation of finding your Meridian, is three hours before or three hours after 12 at noon.

2d. To point the Teleſcope on a Star, tho' not on the Meridian, in *broad day light*.

Having elevated the Equatoreal (or hour) Circle to the Co-Latitude of the place and ſet the declination Semi-Circle to the Star's declination, move the Index of the Hour Circle, till it ſhall point to the preciſe time that the Star is then diſtant from the Meridian * and the Star will then appear in the Glaſs.

* This time you eaſily find from Tables of the right aſcenſion of the Stars.—

After having ſtated theſe two examples of the uſes *peculiar to this Inſtrument*, it is unneceſſary to add, that it is applicable to all the purpoſes to which the principal Aſtronomical Inſtruments (viz. a Tranſit, a Quadrant, and an equal Altitude Inſtrument) are applied.—